PRE-LAB Experiment 15: Heat of Fusion & Solution

Format & Clarity of the Report: See lab report checklist. You are graded on how you format the lab and record your data, not just data collection.

Before class starts: Read the lab for the week carefully before you start writing your pre-lab. The purpose, introduction (if any), and procedure should be neatly written in your lab book before class starts. Keep the introduction and the purpose separate. Prelab questions need to be correctly answered.

Purpose: Address the following in your purpose: The title of this lab is a good place to start for the purpose for this lab.

Introduction: Read the introduction to the lab: Write a method for this section.

Spacing: purpose and procedure, about 2 pages. Data tables, about 2 pages, calculations 2 pages, results table 1 page, questions 1 page.

Pre-lab questions:

1. As the water in the calorimeter cools down, explain what happens in terms of energy on a molecular level.
2. In this lab, when the water loses energy, where does the energy go? [this applies to both parts of the lab.
3. Why do we use a Styrofoam cup and not a metal cup as a calorimeter?

Procedure: This lab requires forethought and a little planning. Here are some suggestions:

1. Gather all the equipment that you will need for Part 1 **<u>before</u>** you start the lab.
2. Make sure the calorimeter is clean; wash it if it is not clean and dry it.
3. You need 2 cups, one inside the other.
4. Check your thermometer. Make sure the alcohol in the thermometer channel is contiguous. If not, get another thermometer.
5. Also, you want to read the sections in Chapter 13 & 11 that we covered in class about this material. [13.1, 11.5]
6. You will need about 300-350mL of water for each part (this is a total of about 900 mL of distilled water. This will insure that all of the trials have the same source of water for each part.
7. Wash your calorimeter with the room temperature water AND re-weigh your calorimeter between trials. You need **<u>three</u>** (3) trials of ammonium chloride and **<u>three</u>** (3) trials of sodium carbonate.

Part 1: YOU WILL REPEAT THIS PART THREE TIMES. You are going to blot the ice before you put it in the calorimeter. Put the paper on the table. Put the ice on the paper. Blot. If you handle the ice, it will melt faster. You have time to do this part three times. Stir gently to distribute the water(s)-don't just stick the thermometer in the water.

Part 2: YOU WILL REPEAT THIS PART THREE TIMES. You need the precise mass of the solid and the water being used. DO NOT DEPEND ON DENSITY—MEASURE! When you add the solid to the cup, insert the thermometer into the solution and start monitoring the temperature. Stir gently. All the solid must be dissolved. If any is left over, your results will be yuck and you must do it all over again.

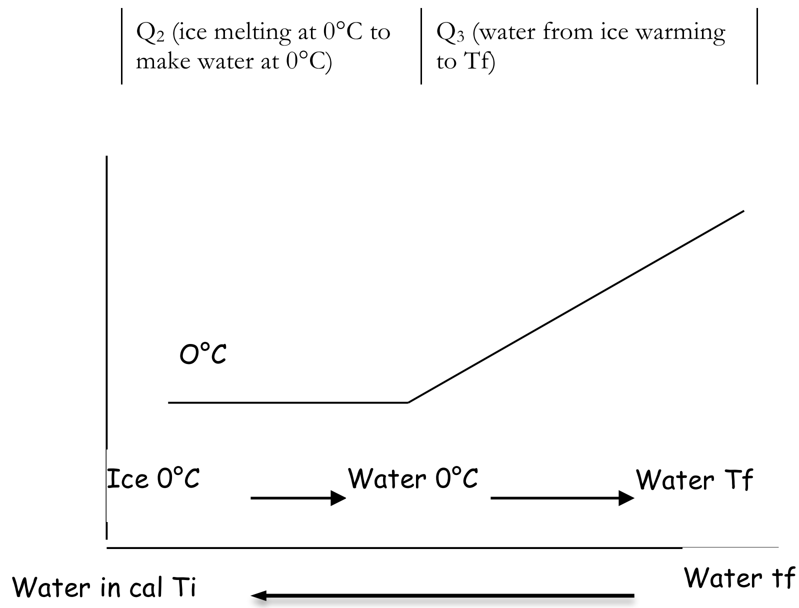
Qualitative Observations/Data Collection: For this experiment, you should have PART II & I: a picture of the setup, observations: what happened to the water in the calorimeter, what happened to the ice, what happened to the solutions?

You should also observe any errors or difficulties that came up when carrying out the procedure (stuff not dissolving, ice not melting fast enough, added too much ice, solids taking too long to dissolve.) This section shows the time, care, and preparation you put into doing the lab before and during class. For this experiment, you should enter your data with the correct significant figures and units into the observation section in a way that is easy to understand and is easily identifiable. This means it corresponds its place in the procedure:

- **PART I:** the mass of the calorimeter before adding water, the mass of the calorimeter after adding water, and after the ice has melted, the temperature of the water before adding ice and after adding ice, (three trials each!)
- **PART 2:** The mass of the calorimeter, the mass of water added, the mass of the two solutes, the temperature of the solution before and after the process has occurred. (Three trials each!). WATCH YOUR PRECISION.

Data Tables: For this experiment, you should transfer your data with the correct significant figures and units from the observation section into a data table that is easy to understand. **PART I**: the mass of the calorimeter before adding water, the mass of the calorimeter after adding water, and after the ice has melted, the temperature of the water before adding ice and after adding ice, (three trials each!) **PART 2:** The mass of the calorimeter, the mass of water added, the mass of the two solutes, the temperature of the solution before and after the process has occurred. (Three trials each!) WATCH YOUR PRECISION

THE GRAPH BELOW MIGHT HELP YOU FIGURE OUT THE PROCESS IN PART I—THEN AGAIN, IT MIGHT NOT. IF IT CONFUSES YOU **<u>DON'T USE IT.</u>**



Data Table (recorded in the table provided: For this experiment, you should have transferred your data neatly (no cross-outs) into a data table. An example is given below.

Part One: the heat of fusion of ice					
Trial number	Mass of empty calorimeter	Mass of calorimeter and water	Mass of ice, calorimeter and water	Temperature of water before ice added	Temperature of water after ice added
Part Two: the heat of solution					
Trial number	Mass of empty calorimeter	Mass of calorimeter and water	Mass of solute	Temperature of water before solute added	Temperature of water after solute added

Calculations: PART I: you should calculate the heat the water originally in the calorimeter released to melt the ice; the heat the water that came from the ice absorbed to warm to the final temperature; the heat of fusion for the three trials and the average Δ Hfus for the three trials. step 7, YOU SHOULD CALCULATE THE AVERAGE, THE % ERROR AND THE % DIFFERENCE.

PART II: In, you should calculate the heat that the solution in the calorimeter absorbed or released in the dissolving process (to do this you need the mass of the solution); the heat of solution of the compounds (ΔH_{soln}) for each trial, the average ΔH_{soln} for each compound, the % difference for each compound.

Graph: No graph

Results Tables: Part I: the heat of the fusion of ice for each trial and the average heat of fusion of ice. You should have % difference and a percent error based on the accepted value of 333J/g. In part II, you should show the average amount of energy absorbed by or given off by the dissolving solid, the heat of solution in kJ/mol with the appropriate sign, and the % difference.

Questions: Answer the questions clearly and completely in your lab book. Use complete sentences, good grammar, and in Standard English. You might want to consider typing these answers, to give you more time to think about the quality of your answer. **WARNING: If I can't read your work due to poor handwriting, you will lose points. Again, I urge you to consider typing your answers.** (No credit if you did not show your work or explain your reasoning). The answers should address the main thrust of each question. Answers involving calculations should have the correct significant figures and units throughout the calculations.

1. Suppose that one were to mix 30.0 g or aluminum pellets, originally at 97.0 °C with 100.00g of water, originally at 23°C, in a perfect calorimeter. What will be the equilibrium, or final temperature of the water (and the aluminum metal)?
2. How could you determine the heat of vaporization of water at 100°C in a similar experiment? (Think steamed milk).
    - Visit your neighborhood Starbucks or (even better) a local coffee shop.
    - Watch the barista warm the milk (cider, cold liquid) using the steam wand.
    - What was the process used to warm the liquid?
    - Where does the heat come from to warm the liquid?
    - What temperature did the liquid finally reach? You might need to ask.'
    - Back to the lab!!
    - Given the following tools: a calorimeter set up (like the one used in class), water, a method to generate steam, thermometers, balances, describe the process for determining the heat of vaporization of water.
3. What other phase changes have you observed in daily life?
4. List three possible sources of error in Parts 1 and 2 (if done) of this experiment.
5. What is the source of energy used to melt the ice in the calorimeter.
6. Which solute gave off heat as it dissolved? Explain where this heat came from. (you might want to read 13.1-13.2)
7. If you accounted for the fact that a small amount of the ice added was already melted, how would the calculated heat of fusion change: would it be less than or greater than the value found in the original calculation?

<u>RECAP OF TERMS AND HOW THEY COME TOGETHER IN A FORMULA FOR THE LAB:</u>

- q_{ice} = energy needed to melt the ice and warm the water that came from the ice.
- q_{warm}= energy needed to warm the water that came from the ice
- q_{melt}= energy needed to melt the ice
- $q_{H2O\ in\ cal}$=energy stored in the water in the calorimeter

$$q_{ice} + q_{H2O\ in\ cal} = 0$$

$$q_{ice} = -q_{H2O\ in\ cal}$$

$$q_{ice} = q_{melt} + q_{warm}$$

Combining these equations gives us

$$q_{melt} + q_{warm} = -q_{H2O\ in\ cal}$$

Rearranging the equation for q_{melt} gives us:

$$q_{melt} = -q_{H2O\ in\ cal} - q_{warm}$$

$$q_{melt} = —(q_{H2O\ in\ cal} + q_{warm})$$

Why is the ΔH_{fus} smaller?

qice—If some ice melts 'before' we add it to the water in the calorimeter, some cold water will be present. Less ice to melt, but the mass of the ice measured is the same…smaller ΔH_{fus}.

a) If some ice was water at 0°C when placed in the calorimeter, what do you think will happen to the final temperature?
   a. Will it be higher or lower change than if only ice were added to the calorimeter?

b) Calculate the final temperature of the water in the calorimeter assuming 10.0 g of ice completely melted.

c) Now assume that 1.00g of the 10.0g turned to water <u>BEFORE</u> the 'ice' was added to the water in the calorimeter. Calculate the final temperature of the water. (careful here! The problem is giving you the mass of ice that has turned to water. In reality, do you really know the mass of the ice that melted?)
   a. Was the temperature higher or lower for the part c?
   b. What do you think is happening here?

d) So what do you think happened in the end? Why do you think the final temperature changed when compared the data in part b vs part c.